2011

Elements of Mechanical Engineering

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1/17/2011

INTRODUCTION

1. Define prime movers. Classify the prime movers. (**July-00, Nov-01, June-05, Nov-05, GTU June-09, Sept-09, Dec-10**)
2. Explain different sources of energy used by prime movers. (**Nov-00, June-08, GTU March-09**)
3. Define zeroth law of thermodynamics, and First law of thermodynamics. (**July-00, Nov-02, June-06, GTU June-09, Sept-06**)
4. What is pressure? How it is measured? What is standard atmospheric pressure? What is vacuum? What is its unit? (**July-00, Nov-02**)
5. What is heat? what is positive and negative heat ? What are the factors on which the heat flow depends? (**July-00, June-06**)
6. What is work? Mention similarities between heat and work. (**Nov-00, Aug-01, June-05**)
7. What is energy and energy conservation? What are the various types of energy? (**July-00, Nov-00, July-04**)
8. Explain the terms : melting point, boiling point and critical point.(**Nov-00, June-05, Nov-05**)
9. What is internal energy of a closed system ?Derive its expression, (**Aug-01**)
10. Explain different types of systems with a neat sketch. (**Aug-01, July-02, Nov-02, July-03, 04, June-05, July-07**)
11. Explain process, path and state.(**Aug-01, June-06**)
12. What is path function and point function? (**Nov-01, 02**)
13. What is flow work? Explain. (**Nov-01**)
14. Define thermodynamic work? How work done is designated? Why? Which sign convention is used for work? (**July-02**)
15. Define: system, surroundings and boundary. Also explain fixed and movable boundary (**July-03, June-06**)
16. Differentiate between
    - **a)** System and surrounding. (**July-04**)
    - **b)** Intensive and Extensive properties (**June-07**)
    - **c)** Heat and Work (**June-08**)
17. Define power, temperature, enthalpy, specific volume of steam, dryness fraction of steam & internal energy.

PROPERTIES OF STEAM

1. With neat sketch explain construction and working of throttling calorimeter. (**July-04, June-05, 08**)
2. Explain what is internal heat of evaporation. (**July-02, Nov-02, June-08**)
3. What is dryness fraction and wetness fraction of a steam? (**Nov-00, 05, July-04, June-05, 06, 08, GTU March-09R**)
4. With a neat sketch describe the working of combined separating and throttling calorimeter. (**Aug-01, June-06, GTU March-09R**)
5. With a neat sketch describe the construction and working of Barrel calorimeter. Also explain how dryness fraction of steam can be determined by it. (**July-03**)
6. Explain what is internal heat of evaporation. (**July-02, Nov-02, June-08**)
7. Define the following terms: (**Nov-05, June-06, 08**)
   - **(i)** Enthalpy of dry and saturated steam
   - **(ii)** Degree of superheat
   - **(iii)**Enthalpy of evaporation
   - **(iv)**Priming

(v) Superheated steam

8. State the difference between:
Superheated steam and wet steam (**June-05**)

9. Prove that dryness fraction + wetness fraction = 1.

10. Define Degree of superheat & Dryness fraction of steam.

11. Determine dryness fraction of steam supplied to a separating and throttling calorimeter.
Water separated in separating calorimeter = 0.45 kg
Steam discharge from throttling calorimeter = 7 kg
Steam pressure in main pipe = 1.2 MPa
Barometer reading = 760 mm of Hg
Manometer reading = 180 mm of Hg
Temperature of steam after throttling = 140 ^{o}C
Take Cps = 2.1 kJ/kg K.

12. The following information is available from test of a combined separating and throttling calorimeter.
Pressure of steam in a steam main = 9.0 bar
Pressure after throttling = 1.0 bar
Temperature after throttling =115 degree centigrade
Mass of steam condensed after throttling = 1.8 Kg
Mass of water collected in the separator = 0.2 Kg.
Calculate the dryness fraction of the steam in the main.

13. A sample of wet steam at a pressure of 25 bar absolute has dryness fraction 0.80. Determine its enthalpy and internal energy.

14. Combined separating and throttling calorimeter is used to find out dryness fraction of steam. Following readings were taken:
Main pressure = 12 bar ab.
Mass of water collected in separating calorimeter = 2 kg
Mass of steam condensed in throttling calorimeter = 20 kg
Temperature of steam after throttling = 110 ^{0}C
Pressure of steam after throttling = 1 bar ab.
Assume Cp of steam = 2.1 kJ/kg K
Calculate dryness fraction of steam.

15. Determine the enthalpy and internal energy of 1 Kg of steam at a pressure 10 bar(abs.), (i)when the dryness fraction of the steam is 0.85 (ii) when the steam is dry and saturated (iii) when the steam is superheated to300ºC. Neglect the volume of water and take the specific heat of superheated steam as 2.1 KJ/KgK.

PROPERTIES OF GAS

1. State the following Charles Law, Boyles Law, Characteristic gas equation.

2. Derive characteristics equation of a perfect gas.

3. Prove the following relations when a gas is compressed according to the law $PV^{\gamma}=C$: (**July-00, July-03**)

$$\frac{\text{Heat rejected}}{\text{Change in internal energy}} = \frac{\gamma - n}{n - 1}$$

$$\frac{\text{Work done}}{\text{Change in enthalpy}} = \frac{\gamma - 1}{\gamma(n - 1)}$$

Hence or otherwise prove that

$$\frac{\text{Change in enthalpy}}{\text{Change in internal energy}} = \gamma$$

4. For polytropic, with usual notations, prove the following : (**Aug-01, July-03**)
   (i) $\frac{T_1}{T_2} = \left[\frac{P_1}{P_2}\right]^{\frac{n-1}{n}} = \left[\frac{V_2}{V_1}\right]^{n-1}$ (**July-04**)
   (ii) Work done = $\frac{P_1V_1}{n-1}\left[1 - \frac{1}{r^{n-1}}\right]$, where r = $\frac{V_2}{V_1}$
5. By using Joule's law and first law, derive the relation for ${}_1W_2/\Delta U$ and ${}_1Q_2/1W_2$ for polytropic process (**July-02, 03**)
6. For adiabatic expansion process, derive the expression of the work done with usual notations. (**Nov-02**)
7. For adiabatic process prove that $PV^{\gamma}=C$ (**Nov-00, 05 July-04, May-05, June-06, 08**)
8. With usual notations prove that Cp – Cv = R. (**Nov-02, June-07, GTU June-09, March-09R**)
9. What is N.T.P and S.T.P? (**Nov-02**)
10. Why gases have two specific heats? (**Nov-01, June-06**)
11. Derive an expression of work done when a gas is expanded as per law $PV^{\gamma}=C$ with usual notations. (**Nov-01, July-02, June-08**)
12. Write about combined gas law, gas constant and non flow process.
13. What is isothermal process? Derive an expression for the work done during the isothermal process.
14. 0.15 m^3 of air at pressure of 900 kPa and 300 °C is expanded at constant pressure to 3 times its initial volume. It is expanded polytropically following the law $PV^{1.5}$ =C and finally compressed back to initial state isothermally. Calculate heat received, heat rejected, efficiency of cycle.
15. An ideal gas is heated from 25°C to145°C. The mass of gas is 2 kg. Determine (i) Specific heats (ii) change in internal energy, (iii) change in enthalpy. Assume R = 267 J/Kg K and γ =1.4 for the gas.
16. A gas whose pressure, volume, and temperatures are 2.75 bar, 0.09m^3 and 185°C respectively has the state changed at constant pressure until its temperature becomes 15°C. Calculate Heat Transferred & Work Done during the process. Take R= 0.29 KJ/Kg K , and Cp = 1.005 KJ/Kg K. (**Nov-00, GTU June-09**)
17. A cylinder contains 0.6 m3 of gas at a pressure of 1.0 bar and 900 ^{0}C. The gas is compressed to a volume of 0.18 m^3 according to law $pv^n = C$. The final pressure is 5.0 bar. Assuming R=0.287 kJ/kg K and γ = 1.4
    Calculate:
    (i) The mass of gas
    (ii) The value of index 'n' for compression
    (iii) The change of internal energy of gas

HEAT ENGINES

1. Prove that the efficiency of the Carnot engine working between the temperature units T_1 and T_2 is equal to$\frac{T_1+T_2}{T_1}$. (**Nov-00, July-04, Nov-05, June-07, GTU Dec-08**)
2. Derive an expression for efficiency of Rankine Cycle with pump work. (**Nov-00**)
3. Derive the equation of efficiency for Diesel Cycle with usual notations. (**Aug-01, July-02, GTU March-09R**)
4. List various source of energy (**June-08**)
5. Prove with usual notations the expression for the efficiency of an air standard Otto cycle.
   The engine is working on ideal Otto cycle. Calculate the air standard efficiency. (**Nov-00, 01, June-05, 06, GTU June 09, 09R**)
6. State the assumptions & limitations of Carnot Cycle and derive the equation of efficiency for Carnot Cycle.
7. State the assumptions & limitations of Carnot Vapour Cycle and derive the equation of efficiency for Carnot Cycle.

STEAM BOILERS

1. Describe with neat sketch: (i) Water level indicator (**July-00, Nov-01, July-02, July-03, June-08**) (ii) Pressure gauge (**July-03, Aug-01, June-05**) (iii) Blow of Cock (**July-00, Nov-02, July-04**)
2. Describe the working of a Lancashire boiler with neat sketch. (**July 2000**)
3. Discuss construction and working of cochran boiler with sketch. (**Nov-01, July-03, July-04, Nov-05, June-06, June-08, GTU Sept-09R, March-10R)**
4. Explain with neat sketch the construction and working of babcock and wilcox boiler, advantages, disadvantages and application. (**Nov-00, June-07, GTU March-09R, Dec-10R**)
5. Enlist factors affecting the boiler efficiency.(**July-00**)
6. What is economiser? Why it is used in a boiler plants? What are the advantages and disadvantages of economiser? (**Nov-01**)
7. Explain equivalent evaporation (**Nov-02, GTU June-09**)
8. Spring Loaded Safety Valve (**July 2007, GTU 2009**)
9. Feed Water Heater or Green's Economiser (**June-07, GTU Sept-09R**)
10. List various Mounting and accessories (**GTU Dec-08, Sept-09R**)
11. Comparison between

(i) Natural circulation and Forced circulation in boiler.

(ii) Fire Tube and Water Tube Boiler (**June-07, June-08, GTU Dec-08, Sept-09R**)

12. Write a short note on: (**Nov-00, July-02, June-05, June-08**)

(i) Fusible plug (**GTU March-10**)

(ii) Lever loaded safety valve

13. Explain the function of following mountings and accessories with neat sketch :

(i) Air preheater. **(ii)** safety valve **(iii)** Superheater **(iv)** Economiser (**GTU Dec-10R)**

14. Explain with neat sketch the constructional details and working of the pressure gauge (**GTU March-10R)**
15. Explain with neat sketch the constructional details and working of the Ramsbottom type spring loaded Safety Valve. (**GTU June-09**)
16. What are high pressure boilers? State their advantages and disadvantages of high pressure boilers(**GTU Dec-10R**)
17. Short note on Lamount boiler.
18. A boiler generates 7.5 kg of steam/kg of coal burnt at a pressure of 11 bar. The feed water temperature = 70 0C. η_{Boiler}= 75%, Factor of evaporation = 1.15. Take C_{ps} = 2.1 KJ/Kg K. Calculate: (1) Degree of superheat and temperature of steam generated (2) Calorific value of coal KJ/Kg (3) Equivalent evaporation in Kg of steam/kg of coal. (**GTU Sept-09R**)
19. What is equivalent evaporation from and at 100 ^{0}C? Explain

    In a boiler test 1200 kg of coal are consumed in 24 hrs. The mass of water evaporated is 1200 kg. Steam pressure is 7 bar. The feed water temperature is 40 ^{0}C, Calorific value of the coal = 30000 KJ/Kg. The steam is dry and saturated. Calculate: (1) Equivalent evaporation (from and at) 100 ^{0}C. (2) Boiler efficiency.

Abstract from steam tables

Pressure bar	Temp ^{0}C	Specific Enthalpy, KJ/Kg	
		h_f	h_g
7	164.96	679.06	2762.0
0.07335	40	167.45	2574.4

Equivalent evaporation from and at 100 ^{0}C. (**Nov-00, June-05**)

INTERNAL COMBUSTION ENGINE

1. State the advantages of I.C engines and external combustion engines. (**Nov-02**)
2. Comparison between Petrol and Diesel Engine. (**Nov-02, June-07, GTU Sept-09R**)
3. How do you classify I.C engines? Explain. (**July-02, June-05, Nov-05, June-08**)
4. With neat sketch explain working of two stroke petrol engine. (**Nov-01, June-07, June-08**)
5. Make comparison between 2–stroke and 4–stroke cycle I. C. Engines. (**July-00, 02, June-05, 06, 08, GTU Dec-09, March-09R**)
6. Describe the construction and working of a Spark plug. Where it is used? Why? (**Aug-01**)
7. Explain following terms related to I. C. Engines, (**June-08**)
   (i) Indicated power (ii) Indicated thermal efficiency
   (iii) Brake power (iv) Friction power
   (v) Mechanical efficiency (vi) Brake specific fuel consumption
8. With a neat sketch explain four stroke cycle I.C engines.(**Nov-00, July-03, July-04, Nov-05**)
9. Give function of following components used in I. C. engines,
   (i) Cylinder (ii) Piston (iii) Connecting Rod
   (iv) Crank (v) Fly Wheel (vi) Crank Shaft.
10. State the function of I. C. Engines and classify the I. C. Engines in detail.
11. With neat sketch explain working of four stroke Diesel engine.
12. Why petrol engines are called as S. I. Engines? And why Diesel engines are called as C. I. Engines?
13. Define compression ratio. State the probable value of compression ratio used for petrol as well as Diesel engines.

SPEED CONTROL

1. What is the purpose of governor? Classify the governing methods used in I.C engines and describe quantity method & Quality method of governing. (**July-02, June-06, GTU June-09**)
2. Explain working of watt governor with neat sketch.(**July-03, July-04, GTU Dec-08**)
3. With neat sketch describe the working of Hartnell governor(**June-05, GTU March-09R, Sept-09R**)
4. Explain: Flywheel using sketch. (**June-08, GTU March-10R)**
5. Explain the function of flywheel with turning moment diagram.(**GTU Dec-08**)
6. What is flywheel? How governor differs from flywheel.(**Nov05**)
7. Differentiate: Governor and flywheel.(**GTU Dec-10R**)
8. State different methods of governing I.C engines and explain anyone.(**GTU March-10R, Dec-10R**)

PUMPS

1. With a simple sketch explain working of centrifugal pump. (**Nov-00, 05, GTU sept-09**)
2. Explain with neat sketch the working of single acting piston pump (**Nov-00, July-04, GTU Dec-08**)
3. What is priming? Explain with a neat sketch vane pump. (**July-02, June-06, 08**)
4. Working of double acting reciprocation pump (**July-03, June-07**)
5. What is pump? Classify pump. (**July-03, June-07**)
6. What is function of a pump? (**June-07**)
7. Explain : Whirlpool chamber type centrifugal pump with neat sketch (**June-08**)]
8. Explain gear pump (**June-08**)
9. Classify centrifugal pump and explain volute type, vortex or diffuser type centrifugal pump. (**GTU June-09**)

AIR COMPRESSORS

1. Mention atleast four industrial and commercial use of compressed air. (**July-00, June-05, 08, GTU March-09R**)
2. With a simple sketch explain the working of Vane type compressor. (**July-00**)
3. For a single stage compressor, with clearance volume, with usual notations prove that work required to compress the air/cycle is given by work done/cycle=$\frac{n}{n-1}P_1\ (V_1\text{-}V_4)\left[\left(\frac{P_2}{P_1}\right)-1\right]$ (**July-00, 02, 03, June-05**)
4. With a simple line sketch explain the working of single stage reciprocating compressor. (**Nov-00**)
5. Derive an expression for work done/cycle for air compressor with usual notation neglecting clearance volume, (**Nov-01, 05, GTU June-09, Sept-09R**)
6. How compressors are classified? (**Nov-02**)
7. Define volumetric efficiency with P-V diagram with usual notations, prove that volumetric efficiency of reciprocating compressor is : $\eta_{vol} = 1 - \frac{V_c}{V_s}\left(r_p^{\frac{1}{n}} - 1\right)$ (**July-04, June-07, GTU Dec-08**)
8. Differentiate between reciprocating and rotary air compressor. (**July-04**)
9. What is clearance volume? Why is it required in a compressor? (**Nov-00, June-06, June-07**)

REFRIGERATION & AIR CONDITIONING

1. What do you understand by 1 Ton of refrigeration? OR What is refrigeration? (**July-00, Nov-01, July-02, GTU Dec-08**)
2. What is refrigerating effect? (**Nov-01, July-02, GTU Dec-08**)
3. What is Co-efficient of Performance (C.O.P) as applied to refrigeration cycle? (**July-00**)
4. What is refrigerant? (**GTU Dec-08**) State their desirable characteristics of refrigerants. (**July-00, July-02, July-04, Nov-05, June-06, June-07, GTU March-09R**)
5. What is refrigerating effect? What is one ton refrigeration?
6. With neat sketch describe the working of vapour compression refrigeration cycle. What is refrigerant and why it is used in this cycle? (**Nov-00, Aug-01, July-02, Nov-02, 05, July-03, 04, June-05,07, , March-09R**) (Draw p-h and T-S chart) (**GTU June-09**).
7. Make comparison between vapour compressions and vapour absorption system(**GTU Sept-09R**)
8. Explain window air conditioner with neat sketch along with its advantages (**GTU Sept-09R, Dec-10R**)
9. What is split air conditioner? State its advantages over window air conditioner.(**GTU Dec-08**)
10. Why air conditioning is required in aircraft? (**July-00, Nov-00, 01, June-08, GTU June-09**)
11. Explain with flow diagram the working of a vapour absorption refrigerator.
12. Define air conditioning and classify the air conditioning systems. State the basic components of air conditioning system.

COUPLINGS, CLUTCHES & BRAKES

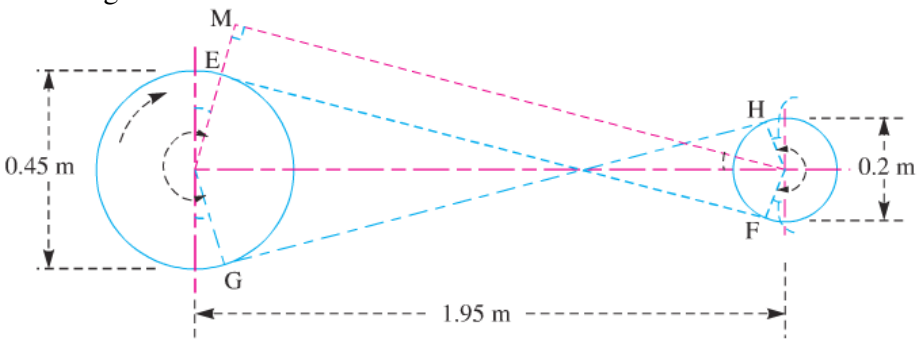
1. How couplings are classified? (**July-00, 02, 05, GTU June-09**)
2. What is clutch? Mention broad classification of clutches. (**July-00**)
3. Give the difference between coupling and clutch. (**Nov-00, GTU Dec-08**)
4. Explain with neat sketch the working of a band brake. (**Nov-00, Aug-01**)
5. With a simple sketch explain the working of disc clutch (**Nov-01, July-03, GTU Dec-08**)
6. With neat sketch describe split-muff coupling. (**July-02, June-05**)
7. Short note on Internal Expanding shoe brake(**July-03, July-04, Nov-05**)
8. Explain oldham coupling. (**GTU June-06**)
9. Evaluate the statement "clutch is a coupling with on – off switch for transmission of power."

10. Draw neat sketch of following and give only application of each.
(i) Flexible coupling (ii) Disc clutch
(iii) Band block brake.
11. What is difference between brake and clutch?
12. Write conditions in which universal coupling and centrifugal clutch are used.
13. How does the working of a clamp coupling differ from that of a muff coupling?
14. Why double block brake is preferred to single block brake?

TRANSMISSION OF MOTION AND POWER

1. Compare individual drive and group drive (**GTU Sept-09R**)
2. Compare belt drive, chain drive and gear drive. (**GTU Dec-08, March- 10R**)
3. List advantages and disadvantages of gear drive (**GTU Dec-10R**)
4. Derive an equation for open belt drive and cross belt drive?
5. Derive an equation for ratio of tensions in a belt.
6. Short note on: Types of belt drive. (**Nov-01, Nov-02, July-04, June-07, GTU March-10R**)
7. What is rider pulleys? How it works?
8. Explain what is plain bearings? (**July-02**)
9. Explain with neat sketch the working of fast and loose pulley. (**Aug-01, June-05, June-06**)
10. What are bearings? How are they classified? Explain thrust bearing (**July-00, July-04, June-08, GTU June-09**)
11. What is chain drive? How the power is transmitted with a chain drive (**July-00**)
12. What are the elements of power transmission? Mention them (**Nov-05, June-08**)
13. Angular contact and Taper Roller Bearing (**July-03**)
14. Write a short note on: Types of Belts. (**Nov-00, July-02**)
What are the materials used for belt belts? (**GTU Sept-09R**)
Compare flat and V-belt drive.
15. Write short note on
(i) Helical gear. (**GTU June-09**)
(ii) Bevel gear.
(iii) Epicyclic gear train.
(iv) Simple and compound gear trains
16. What do you understand by gear train? Discuss various types of gear train.(**GTU Dec-10R**)
17. Write in detail about transmission of motion and power. (**GTU March-09R**)

Examples 1:
Two pulleys, one 450mm dia. and the other 200 mm dia., on parallel shaft 1.95 m apart are connected by a crossed belt. Find the length of the belt required, between the belt and each pulley. If the drive is open, what length of the belt is needed?



Examples 2:
A leather belt with cross sectional area of 2250 mm^2 is used to drive a cast iron pulley 900 mm in diameter at 336 rpm. If the angle of lap is 120° and the stress in the tight side is 2 MPa, find
a) Effective tension on the tight side of belt
b) Centrifugal force acting on the belt

c) Effective tension on the slack side of the belt
d) Power capacity of the belt
The density of the leather is 980 kg/m^3, and the coefficient of friction is 0.35

Examples 3:
Following are the details of a crossed belt drive

Diameter of the driver	:	200 mm
Diameter of the follower	:	400 mm
Center distance of the drive	:	2m
Speed of the drive	:	400 rpm
Angle of contact	:	197.3 °

Determine the length of the belt required. For the drive if tension on tight side is 1.3 kN, and the coefficient of friction between the belt and pulley is 0.25, find the power capacity of the drive.

IMPORTANT ENGINEERING MATERIALS

1. Enlist properties of engineering materials
2. Define
a) Ductility (**GTU Dec-08, Sept-09R**
b) Elasticity (**GTU Dec-08**)
c) Plasticity (**GTU Dec-08, Sept-09R**)
d) Weldability (**GTU Dec-08**)
3. Explain Physical Properties (**GTU June-09**)
a) Electrical properties
b) Thermal properties
c) Magnetic properties
4. Write about engineering materials. (**GTU March-09R**)
5. Explain Composite Materials. (**GTU June-09**)
6. State three Engineering application of following materials (**GTU Dec-10R**)
a) Diamond
b) Composite materials.
7. What do you understand by non-metallic materials? Name any six and state their practical importance.
8. Describe in brief the various non-ferrous metals along with their applications.
9. Short note on ferrous materials
10. Enlist properties of copper? State their applications.